Dynamic Zone Flamelet Model (DZFM) - an efficient yet accurate turbulent combustion model implemented in OpenFOAM

Wei Yao

Institute of Mechanics, Chinese Academy of Sciences/ Associate Professor

Abstract: A dynamic zone flamelet model (DZFM) is proposed to decouple the turbulence-chemistry interactions in supersonic combustion modeling based on local statistical homogeneity assumption. The whole turbulent combustion field is divided into a finite number of control zones, and the chemical status in each zone is represented by a local flamelet, which evolves according to the spatial exchange with its neighbors, chemical reactions controlled by representative temperature, and differential diffusion in the mixture fraction space. Both the zone division and its representative flamelet are dynamically updated for better representing the local chemical status. The zone-based flamelet model is then applied to large eddy simulation of a supersonic hydrogen flame based on 106.23 million cells and 300×91 flamelet zones. The predictions agree well with the DNS calculation, with the auto-ignition process and the flame lift-off phenomenon well reproduced. Sensitivity and cost analysis under different numbers of flamelet zones were also conducted.

Acad. Title: Professor

First Name: Wei

Last Name: Yao

Company/Organization: Institute of Mechanics, Chinese Academy of Sciences

Current Job Title: Associate Professor

Short biography:

Dr. Wei Yao is an associate professor in Institute of Mechanics, Chinese Academy of Sciences since 2013. He obtained Bachelor's and Master's engineering degrees from University of Science & Technology of China (USTC) respectively at 2005 and 2007. He received his PHD degree from University of Ulster (UU) at 2010. His current research interest mainly focuses on Large Eddy Simulation of supersonic combustion. He has published more than 90 papers related to fire and combustion modeling. He was awarded AIAA Best Hypersonics Systems and Technology Paper Award in 2018, and CAS Youth Innovation Promotion Association Award in 2019.